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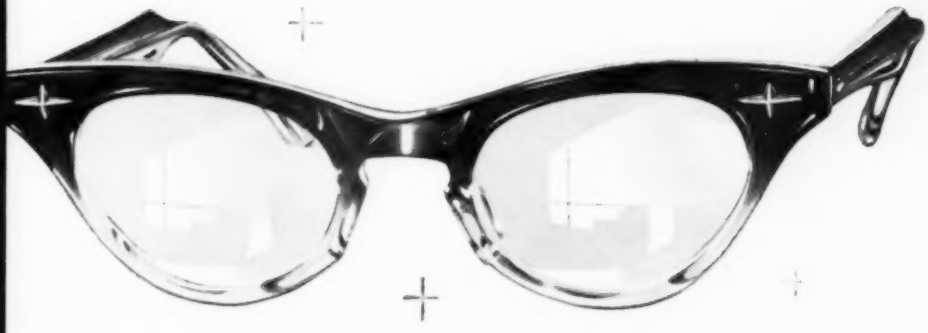

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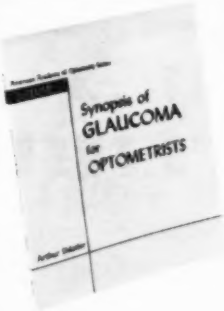

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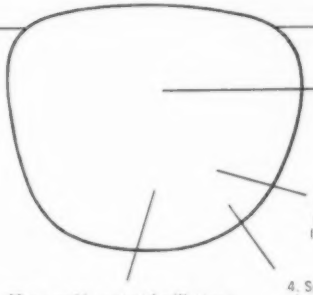

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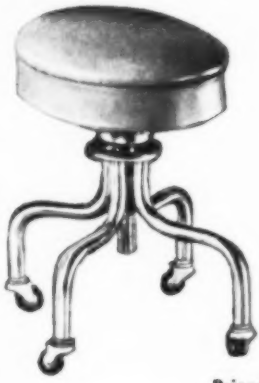

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[1] CLIFTON, C. E. AND HALL, N. C. "RE-STERILIZING ACTIVITY OF CERTAIN CONTACT LENS SOLUTIONS." CONTACTO, THE CONTACT LENS JOURNAL, 3:10, 201-3, 1959.

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AN HISTORICAL REVIEW OF THE ACCESSORY OPTIC TRACTS*

Duco I. Hamasaki† and Elwin Marg‡
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Berkeley, California

INTRODUCTION

In addition to the main optic tracts leading from the eyes to the lateral geniculate nuclei, two pairs of accessory optic tracts have been reported to be present in many animals including man. These two pathways have been extensively studied by early anatomical investigators. These investigations consisted of anatomical and histological examinations of the brains of various normal and experimental animals.

In the normal animals, serial sections of the brains were examined to trace the pathway of the accessory optic tracts. The sections were stained either for the nerve fibers or for the cell bodies.

In the experimental animals, a lesion was produced in a part of the visual system. If the operation was performed in the newborn animal (Gudden's experiment), evidence of the lack of development of the tracts was sought in the adult brain. If the lesion was produced in the adult, the pathway of the accessory optic tracts was traced by following the course of the degenerated fibers.

HISTORICAL SURVEY

In 1870, Gudden[1] noted a nerve fiber bundle which appeared at the anterior edge of the superior colliculus and passed laterally and basally. This bundle ran transversely over the cerebral peduncle and entered the midbrain near the exit of the III nerve. He named it the tractus peduncularis transversus. This tract was first observed in the brain of a rabbit and was later noted in the goat, sheep, pig, dog, and fox. In man, the tract is delicate and very often not seen. Gudden was not able to report on the origin or on the termination of the tractus peduncularis transversus although he demonstrated that its existence depended

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*Read before the annual meeting of the American Academy of Optometry, Boston, Massachusetts, December, 1958. For publication in the February, 1960, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

This article is part of the dissertation "An electrophysiological investigation of the posterior accessory optic tract-tractus peduncularis transversus in the rabbit" submitted in partial satisfaction of the requirements of the Ph.D. degree in the Graduate Division of the University of California, Berkeley, June, 1959.

Supported by a grant from the National Science Foundation, No. G-6195.

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‡Optometrist, Ph.D., Fellow, American Academy of Optometry, Member of Faculty.

on the retina, i.e., if the retina is destroyed the development of the tract is retarded.

In a more extensive paper appearing in 1881, Gudden[2] reported on this tract in more detail. He stated that, in 1875, in an Italian journal, Inzani and Lemoigne[3] claimed to have discovered the tractus peduncularis transversus and described it in a paper published in 1861. However, Gudden reported that even as early as 1810 the superficial course of this tract had been illustrated in a textbook by Gall and Spurzheim but his paper of 1870 was the first to describe the course of the tractus peduncularis transversus in detail.

The intracranial course of the tract was described in the later paper. Gudden studied frontal, sagittal, and horizontal brain sections in normal and experimental animals. He stated that the tract did not originate from the superior colliculus since the latter can be destroyed without affecting the tract. In cross-sections of brains stained with carmine, Gudden was able to see the tract enter the midbrain medial to the cerebral peduncle and lateral to the mammillary body. He was able to follow it dorsally and somewhat laterally between the substantia nigra and a bundle named "Reichert's loop." The tract disappeared in this region and could not be followed. He was not able to detect any atrophy in the midbrain after destroying one or both tracts.

Ganser,[4] 1882, was able to detect the tractus peduncularis transversus in the cat using the Marchi technique.* He also found that the destruction of the occipital cortex did not affect the tractus peduncularis transversus.

Perlia,[6] 1889, reported the presence of the tractus peduncularis transversus in the rabbit. He used the Marchi and Weigert preparations in his investigations. He reported that the fibers of the tractus peduncularis transversus curved around the cerebral peduncle and entered the midbrain and were lost in the reticular substance.

In 1889 Singer and Münzer,[7] employing the Marchi technique, reported that in the adult rabbit, the contralateral tractus peduncularis transversus degenerated after enucleation of one eye. If the enucleation was performed at birth, the tractus peduncularis transversus did not develop.

In his textbook appearing in 1898, Obersteiner[8] described the tractus peduncularis transversus as a thin nerve tract which is very visible

*When a myelinated nerve fiber is cut or injured, the distal portion of the axon degenerates. This is accompanied by chemical changes of the myelin, and the myelin aggregates into small globules of varying sizes. At the same time oleic acid appears which stains readily with osmic acid. By staining the degenerated portions of the myelin with osmic acid, the course of degeneration can be followed.[5]

in many animals but rarely seen distinctly in man. It proceeds from the front of the superior colliculus downwards, centralwards, and backwards across the brachia. It then runs across the cerebral peduncle but its termination is never distinctly seen.

Koelliker,[9] 1896, investigated the tractus peduncularis transversus in the rabbit. Besides confirming the observations of the previous investigators he reported two new findings. First, the nucleus or place of origin of the tractus peduncularis transversus occupied the ventral side of the brain and its end, he felt, would be found in the lower part of the superior colliculus. Second, he observed two other bundles which ran parallel to the "main" tractus peduncularis transversus.

In his investigation of pupillary fibers, Massaut,[10] 1896, noted that the contralateral tractus peduncularis transversus was lost after enucleation of one eye in the rabbit. In several iridectomized rabbits, slight changes were noted in the contralateral tractus peduncularis transversus which led him to conclude that the tractus peduncularis transversus probably contains pupillary fibers.

In a paper dealing with the lateral surface of the midbrain, Retzius,[11] 1898, reported and illustrated the tractus peduncularis transversus in man, chimpanzee and orangutan. He also presented beautiful illustrations which showed the tractus peduncularis transversus in the bear, dog, sheep, pig, rabbit, cow, horse and reindeer. Only in the kangaroo was the tractus peduncularis transversus not observed.

In 1898, Tümianzew[12] reported his findings in two rabbits. Using the Marchi technique, he noted degeneration of the contralateral tractus peduncularis transversus after enucleation of one eye. He did not find any degenerated fibers going to the oculomotor nucleus. He stated that the tractus peduncularis transversus did not take origin from the superior colliculus. He concluded that a part of the tractus originated from a ganglion which lay near the anterior edge of the superior colliculus.

Bach,[13] 1900, reported that the contralateral tractus peduncularis transversus degenerated after evisceration of the bulb. He was not able to find the tractus peduncularis transversus in the cat, ape and in man.

In a paper dealing mainly with the relationship of the superior colliculus to the visual system Pavlow,[14] in 1900, observed a small bundle of degenerated fibers between the cerebral peduncle and the corpus Luysi (nucleus subthalamicus) which he recognized as the tractus peduncularis transversus. This observation was made in rabbits after one eye was enucleated and the brains prepared by the Marchi method.

Berl,[15] 1902, also used the Marchi technique in his investigation

of the rabbit. He found degeneration of the contralateral tractus peduncularis transversus after enucleation of one eye as reported by previous investigators. An occipital lesion did not affect the tract. Very strangely, the tractus peduncularis transversus degenerated on both sides when an occipital lobe lesion and an enucleation were performed.

Frankel-Hochwart,[16] 1902, reported that the tractus peduncularis transversus was not present in the congenitally blind mouse, *Spalax typhlus*.

Münzer and Wiener[17] reported their findings in 1902. As reported by Berl, the tractus peduncularis transversus was not affected when the occipital lobe was destroyed. In addition they were able to trace the course of the tractus peduncularis transversus in the midbrain. Part of the fibers end dorsal to the substantia nigra while a second part progresses further upwards to enter the superior colliculus above the nucleus suprageniculata. A fiber bundle which originated from the nucleus suprageniculata was traced back to the nucleus tractus peduncularis transversus. They believed that these fibers were centrifugally active.

In 1903, Marburg[18] presented the results of his comparative investigation of the basal optic root. In the guinea pig he was able to trace the fibers of the tractus peduncularis transversus to the nucleus which lies ventrolateral to the red nucleus, dorsal to the substantia nigra and at the level of the posterior end of the mammillary body. He also observed the tractus peduncularis transversus in the marsupial (*Marcopus*, *Phascolarctus* and *Perameles*), the sloth, the opossum, the pig and the horse. In the seal only part of the tractus peduncularis transversus was noted. In two human series he detected the tractus peduncularis transversus. From comparative studies on lower vertebrates he concluded that the tractus peduncularis transversus was homologous to the basal optic root of amphibians, reptiles and birds. The nucleus tractus peduncularis transversus was homologous to the ganglion ectomammillaris. Marburg could not find any fibers which passed from the nucleus tractus peduncularis transversus to the superior colliculus.

During the course of his experiments on the basal olfactory bundle, Wallenberg,[19] 1903, destroyed the optic tract in guinea pigs. He noted a narrow bundle of blackened fibers between the angle of the superior colliculus and the medial geniculate body. He was able to follow this bundle, the tractus peduncularis transversus, to its nucleus in the midbrain. He was unable to trace any fibers to the superior colliculus as reported by Münzer and Wiener.

Bochenek,[20] in 1908, examined the brains of seven rabbits. The rabbits were killed 14 to 15 days after unilateral enucleation and the

brains were prepared by the Marchi technique. Bochenek followed the entire path of the degenerated tractus peduncularis transversus easily. His observation on the course of these fibers is identical with those of the previous investigators.

Next to the tractus peduncularis transversus, Bochenek found, in all seven rabbit brains, an optic fiber bundle which had not been described until then. He named it the fasciculus accessorius optici anterior. This tract could be first seen as a distinct bundle at the most posterior part of the chiasma and consisted of crossed fibers. At this level the fibers lay on the bottom of the brain under the fibers of Gudden's commissure.* They were separated from the fibers of the primary optic tract by the non-degenerated fibers of Gudden's commissure. The bundle followed the base of the brain back to the level of the mammillary body at which point it bends medially under the cerebral peduncle. It runs dorsally between the fibers of the cerebral peduncle and ends in the gray substance which corresponds to the posterior part of the nucleus subthalamicus. Bochenek concluded that the anterior accessory optic tract runs from the retina to the nucleus subthalamicus because of the Wallerian degeneration after enucleation. However, Bochenek stated that it was not out of the question that centrifugal fibers were associated with the centripetal fibers.

In his book published in 1911, Edinger[21] summarized his findings on the tractus peduncularis transversus. In the experiments using the Marchi technique, he noted some Marchi granules in the tractus peduncularis transversus; however, the majority of the fibers remained normal. This finding plus the observation of fibers passing from the III N to the nucleus tractus peduncularis transversus led Edinger to state that the tractus peduncularis transversus was actually part of the ciliary nerve. The nucleus tractus peduncularis transversus, he felt, was part of the ciliary ganglion that had failed to migrate orbitally.

In 1911, Loepp[22] also reported his findings in the rabbit. The rabbits had one eye enucleated and were killed about 20 days after the

*Three supraoptic commissural systems have been described:[25, 26, 36] (1) Commissure of Ganser—lies below the floor of the third ventricle and above the optic chiasma. The fibers are heavily myelinated and can be traced laterally and dorsally to the subthalamic region. This bundle most likely connects the subthalamic regions of opposite sides. (2) Commissure of Meynert—lies slightly dorsal and caudal to the chiasma and ventral to the Commissure of Ganser. It consists of myelinated fibers which run laterally and dorsally. Some of the fibers penetrate the medial forebrain bundle and end in the region of the nucleus subthalamicus. Others pass into the zona incerta. (3) Commissure of Gudden—lies ventral to the chiasma and optic tract. It runs dorsally and laterally and ends in the medial geniculate body. It is generally believed to connect the two medial geniculate bodies. None of these commissural systems has been found to degenerate after enucleation.

operation. He observed some degenerated fibers, the anterior accessory optic tract, ventrolateral to the third ventricle. These fibers penetrated the cerebral peduncle and passed into the nucleus subthalamicus. Thus he was able to confirm the observations of Bochenek.

Loepp also described the course of the tractus peduncularis transversus. He reported that this tract consisted only of crossed fibers. It splits from the main optic tract at the lateral margin of the medial geniculate body and passes ventromedially around the cerebral peduncle. Just anterior to the exit of the III N, between the medial margin of the cerebral peduncle and the lateral margin of the mammillary body, it penetrates the midbrain. The fibers of this tract end in a nucleus which lies ventrolateral to the red nucleus.

In his book, Ramon y Cajal.[23] 1911, presented a description of the course of the tractus peduncularis transversus. He also presented a detailed histological description of its terminal arborization in the midbrain.

In 1915 Kosaka and Hiraiwa[24] published their experimental findings on various animals using the Marchi technique. Their observations in the rabbit were in a large part identical with that of Bochenek and Loepp. On the lateral side of the tuber cinereum, they saw a small bundle of optic fibers which was separated from the main mass of optic fibers by Meynert's and Gudden's commissures. The fibers passed into the cerebral peduncle and, as stated by Bochenek and Loepp, are destined for the nucleus subthalamicus. In Kosaka and Hiraiwa's preparations only a few fibers passed to the nucleus subthalamicus: some bend laterally while others proceed dorsally. The fibers passing laterally re-enter the main optic tract while the dorsally proceeding fibers end in the ventral part of the lateral geniculate nucleus with the other optic fibers. Thus Kosaka and Hiraiwa concluded that the "anterior accessory optic tract" represented a small aberrant bundle of optic fibers which separated from the main optic tract only to rejoin it more caudally.

Kosaka and Hiraiwa were able to detect degeneration of the tractus peduncularis transversus in rabbits, guinea pigs and rats after enucleation. The tract, however, showed no Marchi granules after damage to the occipital lobe in these same animals. They were also able to demonstrate that the tractus peduncularis transversus contained no commissural fibers. In dogs, cats, goats, and apes, Kosaka and Hiraiwa were not able to detect any degeneration of the tract following enucleation. This they believed was due to the fact that the fibers of this tract are so finely myelinated. The cells of the nucleus tractus peduncularis transversus showed no chromatolysis after enucleation in rats, rabbits, guinea pigs

and dogs. However, the nucleus was somewhat increased in size and the cells were displaced by swollen degenerated fibers. They believed that no optic fibers originated from this nucleus: also it did not send fibers dorsally or spinally.

Tsai,[25] in 1925, studied serial sections of the brain of the opossum, *Didelphis virginiana*, stained by either the Wright or silver method. The tractus peduncularis transversus was noted as a small fascicle which splits off the main optic tract near the lateral geniculate nucleus. This small bundle courses caudally over the cerebral peduncle and takes a superficial position on the ventrolateral surface of the hypothalamus and mesencephalon. Just anterior to the exit of the III N it curves medially under the peduncularis tegmenti to end in the nucleus tractus peduncularis transversus. This nucleus was observed to be medial to the substantia nigra, lateral to the nucleus tegmenti ventralis and ventral to the red nucleus.

Tsai noted that the anterior accessory optic tract splits from the main optic tract midway between the chiasma and the cerebral peduncle. It ran caudally and dorsally with the commissure of Meynert and lay medial to the main mass of optic fibers. About the middle of the cerebral peduncle some of the fibers, together with the fibers of Meynert's commissure, turned medially to penetrate the longitudinal bundles of the cerebral peduncle and end in the nucleus subthalamicus. Other fibers were observed to curve over the dorsal surface of the cerebral peduncle and turn ventrally to reach the nucleus subthalamicus.

Gurdjian,[26] 1927, examined 36 complete brain series of the normal albino rat. He was able to identify the tractus peduncularis transversus and its nucleus. However, he was not able to identify the anterior accessory optic tract or any fibers entering the nucleus subthalamicus. He felt that this would be mechanically impossible.

In 1931, Rioch[27] reported his findings in the brains of dogs, cats and aevis (a small carnivore) stained for the myelin sheath. At the dorsal margin of the cerebral peduncle a group of fibers was noted which turned caudally out of the posterior border of the optic tract. At the level of the red nucleus the fibers course dorsally around the medial margin of the cerebral peduncle to end in the nucleus tractus peduncularis transversus.

As the main optic tract passed over the cerebral peduncle, Rioch observed some fibers leaving its medial surface to mix with the fibers or Meynert's commissure. These fibers ran diagonally through the cerebral peduncle toward the zona incerta and the nucleus subthalamicus.

In two papers, 1931 and 1932, Le Gros Clark[28, 29] presented his

findings on the accessory optic tracts in the rat. Using the Marchi technique, he was able to see the anterior accessory optic tract. It consists of fibers which leave the main tract as it passes obliquely across the crus cerebri. However, he was able to follow these fibers only to the superficial aspect of the cerebral peduncle. No degenerated fibers could be seen penetrating the cerebral peduncle to reach the nucleus subthalamicus.

The posterior accessory optic tract leaves the main optic tract as the latter lies in topographical relation with the medial geniculate body. It forms a fine strand which runs obliquely in a caudoventral and medial direction across the cerebral peduncle. The fibers end in the nucleus opticus tegmenti and the medial end of the substantia nigra. Some fibers were observed extending more dorsally into the tegmental region of the midbrain.

Lashley,[30] in a paper appearing in 1934, reported on his findings in the rat. The retina was destroyed by an incision through the back of the bulb and the brain prepared by the Marchi technique. He observed that only the contralateral anterior accessory optic tract showed any degeneration. The fibers of this tract travelled with the fibers of Meynert's commissure up to the inferior margin of the cerebral peduncle where they divided into two branches. The superior branch continued along the superficial margin of the cerebral peduncle and the majority of the fibers rejoined the main optic tract. The inferior branch, which contained the greater numbers of fibers, passed along the ventromedial edge of the cerebral peduncle and finally joined the fibers of the posterior accessory optic tract. Thus Lashley concluded that the "anterior accessory optic tract" is really part of the posterior accessory optic tract.

Although a special effort was made, Barris, Ingram and Ranson,[31] 1935, were able to detect neither the anterior, nor the posterior accessory optic tracts. They used the Marchi technique in cats with various types of lesions.

A good description of the accessory optic tracts is presented by Ariens-Kappers, et al.[32] in their excellent textbook of neuroanatomy published in 1936.

Frey,[33] 1937, reported on his comparative study of the basal optic root. His findings led him to conclude that the basal optic root was homologous to the anterior accessory optic tract of Bochenek and not to the tractus peduncularis transversus as stated by Marburg. The main part of the fibers go to the basal optic nucleus which lies in the region of the exit of the III N. Only a few fibers go in the direction of the nucleus subthalamicus. The fibers that pull away from the anterior edge of the superior colliculus and run toward the medial geniculate body, the

classical tractus peduncularis transversus, represent a secondary connection from the basal optic nucleus.

Tsang,[34] 1937, was not able to identify the anterior accessory optic tract nor to detect any changes in the nucleus subthalamicus in unilaterally and bilaterally enucleated rats. However, he did observe the posterior accessory optic tract and described its course. His description of the posterior accessory optic tract is similar to the reports of previous investigators. In the bilaterally enucleated rats, he noted that the tract was atrophied proportionately to the period of enucleation. However, even seven months after enucleation some fibers were still present in this tract. This suggested that the posterior accessory optic tract was really composite in nature, i.e., it contained both centripetal and centrifugal fibers.

Bodian,[35] in 1937, examined the brain of the opossum. He noted that the posterior accessory optic tract degenerated completely following lesions in the retina and could be easily followed. An intensive search failed to reveal any fibers which might be called the anterior accessory optic tract.

Jefferson,[36] 1940, concerned with the effect of light on the gonads, studied both normal and experimental brains of ferrets to see if a pathway could be found which might account for this phenomenon. He was unable to detect either the anterior or the posterior accessory optic tract.

In a paper published in 1941, Packer[37] reported the presence of both accessory optic tracts in the *Phalanger* (a marsupial). In experimental animal degeneration granules were observed in both tracts but he noticed that the two tracts joined together just anterior to the nucleus of the posterior accessory optic tract and ended in this nucleus. Thus his findings are similar to those of Lashley.

In a very comprehensive paper appearing in 1941, Gillilan[38] reported her findings on the accessory optic tracts in various normal and experimental animals.

In the chiroptera (three different species of bats), the posterior accessory optic tract (Gillilan preferred to call it the basal optic root) was present although very thinly medullated. Its origin in the retina was proved by enucleation experiments. Primary optic fibers were traced to the reticular gray, the substantia nigra, the oculomotor nucleus and the nucleus interpeduncularis. Secondary fibers connected the nucleus of the posterior accessory optic tract with the reticular gray, the substantia nigra, the oculomotor nucleus and the contralateral nucleus of the posterior accessory optic tract. The anterior accessory optic tract was also observed.

In the insectivora (shrew) the posterior accessory optic tract is a small bundle which takes the usual course. The anterior accessory optic tract was also noted.

In the rodentia, Gillilan examined the brains of white rats, mice, guinea pigs and squirrels.

The posterior accessory optic tract in the white rat consisted of finely medullated fibers and followed the usual course. Primary fibers were traced to the contralateral nucleus of the posterior accessory optic tract through the supramammillary decussation. Secondary connections pass to the substantia nigra, the reticular gray, the oculomotor nucleus and possibly other nuclei. The anterior accessory optic tract, although very difficult to identify, was observed passing through the cerebral peduncle in scattered fibers and entering the nucleus subthalamicus.

The findings in the mouse were similar to those in the rat.

The posterior accessory optic tract is especially well medullated in the guinea pig and can be easily followed to the nucleus. Secondary fibers from the nucleus can be followed to the same midbrain nuclei.

Gillilan reported that the posterior accessory optic tract in the squirrel took the usual course and was large and well medullated. Primary and secondary fibers ran to the same nuclei. The anterior accessory optic tract fibers were fine and very thinly medullated.

Gillilan reported that the posterior accessory optic tract existed in the carnivora (cat). It is primarily an unmedullated tract and therefore only identifiable in silver material. Although the anterior accessory optic tract could not be identified, Gillilan felt that it too may exist as an unmedullated tract.

In the ungulata (elephant) the posterior accessory optic tract is relatively small and follows the same pattern as in the other mammals. The anterior accessory optic tract could not be identified with certainty.

In monkeys (*Macaca mulatta*) the posterior accessory optic tract was noted as it crossed in the ventrocaudal part of the chiasma. The fibers are very thinly medullated and unmedullated but can be readily distinguished from the heavily myelinated optic tract fibers. They separate from the main optic tract as the latter enters the lateral geniculate nucleus and course medially and caudally below the peduncle. The nucleus of the posterior accessory optic tract is a fairly small, elongated mass that lies dorsomedial to the cerebral peduncle. The substantia nigra, pars compacta, adjoins the nucleus immediately at its dorsal tip and the mammillary body lies medial to the rostral portion of it. Further connections of the nucleus could not be determined nor could the anterior accessory optic tract be identified in normal materials.

The Marchi materials confirmed the observations made in the normal materials.

A section on the accessory optic tract is included in a review article on the visual centers of the brain by Le Gros Clark.[39]

In his book on "The Brain of the Tiger Salamander," C. J. Herrick,[40] 1948, stated that the basal optic root is present in all classes of vertebrates from cyclostomes to man. He stated that two possible functions had been suggested for it in the *Amblyostoma*. The more primitive of these is to act as a general activator of the ocular and somatic muscles in response to visual stimuli manifested in such behavior as the "regarding reaction." In the second place the structure and connections of the area centrolateralis pedunculi, within which the basal optic fibers terminate, suggests that this neuropil may be part of the apparatus of conditioning of visual reflexes.

Hess,[41] in 1958, removed one eye from fetal guinea pigs ranging in gestation age from 35 to 55 days. He observed that the posterior accessory optic tract was present only on the ipsilateral side, i.e., the contralateral posterior accessory optic tract had not developed.

DISCUSSION

There is very little doubt that the posterior accessory optic tract exists in all of the animals studied. Only Barris, et al., in cats, and Jefferson, in the ferret, were unable to detect this tract. It is not surprising that these two negative reports occurred in carnivores since Gillilan has reported that this tract is unmedullated in the carnivores.

There seems to be some evidence that the posterior accessory optic tract contains centrifugal fibers in addition to the centripetal ones. Münzer and Wiener felt that the tractus peduncularis transversus had some centrifugal action. Edinger stated that the tractus peduncularis transversus was actually part of the ciliary nerve. Tsang noted that even seven months after enucleation, some fibers were still present in this tract. These observations would indicate that the tractus peduncularis transversus may be composite in nature, i.e., containing both centripetal and centrifugal fibers.

A few authors have commented on the probable function of the posterior accessory optic tract. Massaut stated that the tractus peduncularis transversus probably contained pupillary fibers. As stated above, Edinger felt that the tractus peduncularis transversus was part of the ciliary nerve. Rioch suggested that it is concerned with muscular coordination because of the close association of this tract with the extrapyramidal system. Gillilan stated that the function of the accessory optic tracts was to establish a pathway between the retina and various sub-

thalamic and midbrain efferent centers, such as the nucleus subthalamicus, the substantia nigra, the oculomotor nucleus and the midbrain tegmental gray. It has also been thought that the influence of light on the gonads may be mediated by these pathways via the pituitary gland.

The existence of the anterior accessory optic tract is more doubtful. Four different observations have been reported: (1) it exists as a separate and distinct bundle: (2) it is an aberrant branch of the primary optic tract and rejoins it: (3) it runs as a separate bundle but joins the posterior accessory optic tract and ends in the same nucleus; and (4) it does not exist.

Only Tsai and Le Gros Clark, et al.,[42] have commented on the probable function of the anterior accessory optic tract. Tsai postulated that these optic connections are significant for the coordination of vision and motility because of the connections of the nucleus subthalamicus with the substantia nigra and globus pallidus.

Le Gros Clark, et al., showed that the estrus cycle in the ferret was altered if the optic nerves were cut. However, the estrus cycle remained normal when the dorsal lateral geniculate nucleus, or the superior colliculus or other parts of the midbrain were destroyed. Therefore, they concluded that the pathway is either through the ventral lateral geniculate nucleus or by the anterior accessory optic tract and the nucleus subthalamicus.

SUMMARY

There is very little doubt that the tractus peduncularis transversus (posterior accessory optic tract, basal optic root) exists. It has been reported to be present in chiropteres, insectivores, rodents, carnivores, ungulates and primates.

It consists of decussated fibers and runs with the main optic tract to the ventral margin of the lateral geniculate nucleus. At this level it splits off and runs as a separate bundle ventrocaudally over the cerebral peduncle to the region of the exit of the III N. The fibers turn dorsally over the medial edge of the cerebral peduncle and enter the nucleus. The nucleus of the posterior accessory optic tract lies ventrolateral to the red nucleus, medial to the substantia nigra, posterior to the mammillary body and anterior to the exit of the III N.

Primary fibers have been observed to pass to the substantia nigra, the lateral reticular gray, the oculomotor nucleus and the interpeduncular nucleus. Secondary fibers have been traced from the nucleus of the posterior accessory optic tract to these same nuclei as well as to the contralateral nucleus. Fibers have also been reported either to go to or to come from the superior colliculus.

There is some evidence that the tractus peduncularis transversus contains both centripetal and centrifugal fibers.

The presence of the anterior accessory optic tract is more doubtful. It has not been observed in the carnivores and primates although it has been reported in chiropterers, insectivores and rodents. The fibers are reported to originate from the retina and are completely decussated. They run with the main optic tract up to the level of the mamillary body. Here the fibers bend dorsally and penetrate the cerebral peduncle. The fibers pass through the cerebral peduncle and end in the nucleus subthalamicus.

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A STUDY OF VISUAL PERFORMANCE*

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INTRODUCTION

The fundamental variables in a visual task were defined by Cobb and Moss (1928)[1] as luminance, contrast, size and duration.

In order to evaluate the difficulty of any particular task these variables must be considered. One of the problems of illuminating engineering is the prediction of the change in visual performance with changes in illuminance. A measure of visual performance is required. Weston (1945)[2] formulated such a measure, which took into account the fundamental variables. His data have since been applied to illuminating engineering specifications. However, they are not applicable to all situations. Fortuin (1951)[3] also evolved a performance unit based on his experimental studies.

There are, however, some variables in the problem whose interrelationships have not yet been adequately determined. The temporal aspects of a visual task involve rate as well as duration. An assessment of performance should take these into consideration in its formulation. The investigation of the effects of duration of exposure and presentation rate in a visual task involving the identification of the position of the break in a Landolt ring under various conditions of luminance and contrast has been the purpose of this study. An apparatus was designed to provide control of the variables such as luminance, contrast, size, duration and presentation rate. Frequency of seeing and reaction time data were used in assessing performance.

The task in Weston's study was to cancel Landolt broken rings of a specified orientation mixed in with rings of different orientations. In each run the size of ring, the contrast and the luminance was kept constant.

The measure of performance took into account both speed and accuracy. If we let A equal the number of correctly cancelled rings, and B the number of rings of the specified orientation which could have

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been cancelled, A/B is a measure of accuracy. Dividing A into the time t required for the whole task should yield the gross cancellation time per ring for the task. This time, however, includes more than just discrimination time. By subtracting action time from the gross cancellation time, the net discrimination time was obtained, the reciprocal of which was used as a measure of speed. Multiplying the speed factor, $1/(t/A - a)$, by the accuracy factor, A/B yields an index of performance which includes speed and accuracy.

While performance is a function of both speed and accuracy, the question must be raised of how each factor should be weighted and how the temporal components, rate of presentation and duration of presentation may be included in the evaluation of performance.

To measure action time Weston marked in red the rings oriented in a given direction and had his subjects cancel these rings. He then divided the number of red marked rings into the time required. The red marked rings require no time for discrimination. This definition of action time is not to be confused with the other meaning of action time which is the minimal duration of a stimulus for a maximal response.

APPARATUS

The apparatus was designed to present intermittently a Landolt ring, the orientation of which was varied randomly from one presentation to the next. In such a series of presentations the various conditions of luminance, contrast, presentation rate and duration of exposure were kept constant, but were varied from one run to another.

Figure 1 is a schematic drawing of the unit. The target E is presented at the left and the eye Z appears at the right hand side of the drawing. The optical ray trace shown is a chief ray plot which shows certain properties of the system.

The principle involved in target presentation is similar to that used in a Vari-Typer. The target E is mounted on a shaft which follows an oscillating arm rotating around the same axis. For each of the four resting positions of the target there is a solenoid, which when activated, stops the target so that it is momentarily fixed and during this time it is presented to the eye for a given duration.

The lenses G, H, J, K and R form an image of the target in the plane tangent to the screen S, which is illuminated and provides a bright surround for the target. The image of the target is centered in the aperture in the screen S.

An auxiliary source M illuminates a piece of opal glass Q. The veiling glare from this source enters the system by means of reflection from a piece of plate glass P properly oriented. By this means, contrast

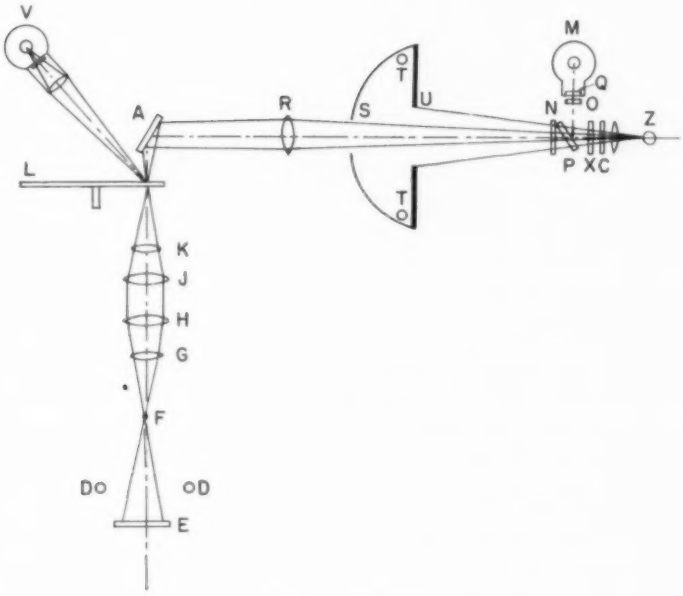

Fig. 1. Apparatus.

can be controlled. The patch of veiling luminance covers the same area as the rectangular opening in the screen U. Two pieces of polaroid N and O cross polarize the two beams which are combined at P. The polaroid filter at X is rotated to change the contrast of the Landolt ring. This is accomplished without changing the luminance of the surround.

The luminance level of the surround S is uniform and the same as that of the immediate background of the target. When the sectored disc L intercepts the beam the aperture in S is uniformly illuminated by light reflected from the front of the sectored disc and has a luminance equal to that of S. The luminance level is adjustable by the use of neutral density filters C.

A shunt wound DC motor controls the timing of all elements. The motor is variable in speed, but when set, maintains constant speed. The shutter is operated through a gear train driven by the motor. The variability in speed allows variation in presentation rate. The size of the open sector determines the duration of presentation. This provides two time controls, the rate of presentation and duration.

The same motor which controls the rate and duration of presentations also controls the system which (1) selects the orientation of the target for the successive presentations, (2) evaluates the subject's response as right or wrong and (3) starts the stop clock at the beginning of each exposure, and stops the apparatus at the end of 116 presentations.

The subject, responding to the stimulus, presses one of four contact buttons conveniently arranged in front of him. The response buttons are arranged in locations corresponding to the positions of the break in the ring: left, right, up and down. Each button stops the timer and activates one or more of eight electronic counters.

The recording apparatus consists of a stop clock which gives the sum of the reaction times for all of the 116 exposures and electronic counters which count the total number of times the subject pushes each button and the number of correct responses he makes with each button. A stop watch is used to measure the total time required for each run.

The subject can respond twice to the same stimulus, but is instructed to try to avoid this. The first of these responses stops the clock. He may fail to respond to a given stimulus before the next is presented. In this case a whole interval from the beginning of one stimulus to the beginning of the next is recorded as reaction time. If he responds to the first stimulus after the second stimulus begins, this stops the clock until the third stimulus starts. The recording apparatus evaluates such a response as if it were a response to the second stimulus.

As shown in Figure 1, the entrance pupil of the eye is conjugate to the shutter L. The natural pupil was used in making all observations.

The stimulus pattern is shown in Figure 2. The rectangle is the aperture in screen U which limits the bright surround for the target. The circle is the aperture in the screen S, and is the dividing line between the surround and the immediate background of the target. The areas on the two sides of this boundary have the same luminance, but there is a slight color difference which makes the boundary visible and helps the subject keep his attention directed to the center of the aperture where the Landolt ring is intermittently presented.

The surround subtends 5° of visual angle in each direction and the immediate background subtends 35′. The break in the Landolt ring subtends 1.5′ of visual angle.

The apparatus was set up in a dark room. The distance from the entrance pupil to the screen S was five meters.

PROCEDURE

On the basis of Weston's work (1945)[2] the present study was restricted to a single target size. The break in the ring subtended an

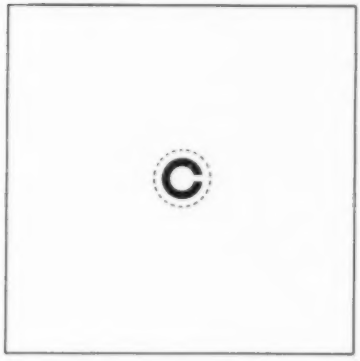

Fig. 2. Stimulus pattern presented to the subject.

angle of 1.5′ of arc at the eye. The background luminance was varied through a range of 5 steps in ½ log units, from 206.3 to 2.06 foot-lamberts, i.e., a total of two log units. Performance measures were obtained under the above conditions for five presentation rates at 50 millisecond exposure duration for various contrasts. In a study of the effect of variation of duration on performance, exposures were varied from 30 to 150 milliseconds for various levels of contrast. The rate was kept constant at 20 per minute.

In order to eliminate the possibility of auditory cues influencing the results (i.e., noisy solenoids, relays), the observers wore earphones into which the output of a white noise generator was directed. This successfully masked the noise of the solenoids and the clicking of the relays, in effect, eliminating the auditory cues.

In order to determine the proper length for a testing session, and possibly to demonstrate the onset of fatigue, one subject performed a series of 13 consecutive trials at constant luminance, contrast and speed. With continued testing, the raw score declined at a gradual rate. On this basis, the length of testing session was limited to five runs, approximately one hour. After at least one hour of rest, the task could be repeated.

Subject 1 performed an entire series of runs under conditions of constant target size 1.5′ for the break in the ring, constant duration of exposure, 0.050 seconds, for five speeds, at various levels of luminance and contrast. Performance was recorded in terms of number of correct responses in a run obtained from the automatic counters. The total number of responses was also recorded. Reaction time was obtained

from the timer while the actual time for the run was measured with a stop watch.

The total number of responses did not always equal 116 since there were occasions when the machine failed to stop the target at one of the four standard positions. The target was seen cocked at an angle and the subject was instructed not to respond when this occurred. There were also occasions when the subject failed to respond prior to the next stimulus. The frequency of such failures was negligible. They occurred only 75 times in 13,340 presentations in the first major experiment. Perhaps some of the failures to respond should have been added to the total correct since by guessing alone the subject could get one out of four correct. This, however, was not done.

In the event that a response was not made, the clock continued to run uninterrupted until the next response. Correction for misses indicated by the counters was applied to the total reaction time by subtracting the average time required for one presentation for each response omitted.

A minor experiment was performed to determine the time required to detect the presence of a ring and respond to it. Fifty reactions to an easy to see target were timed for each of these subjects.

SUBJECTS

Two subjects were experienced observers in physiological optics experiments. The third subject learned the task rapidly. Acuity was corrected to 20/20 with auxiliary lenses at the observers' station.

Instructions to the subjects were as follows: "You will observe a number of presentations of a Landolt ring with the opening in one of 4 positions: up, down, left, right. They will appear singly, at the center of the screen, at regular intervals. Note the panel in front of you. Use any two fingers of each hand. Place each finger on a button. Feel them, press them one at a time to make your responses. You will see that the panel is arranged with the buttons corresponding to the positions of the opening in the ring. During the experiment, you are to respond to each target presentation by pressing the key corresponding to the position of the opening of the ring. Do not respond more than once for each target. Do not try to correct a mistake by pressing another key. Do not try to respond to the previous target once the next target is shown."

RESULTS

The results of a complete series of runs for all levels of luminance, contrast and rate have been plotted in the five upper graphs in Figure 3. This represents a total of 13,340 target presentations with only 75 instances in which no response was made. These "misses" can there-

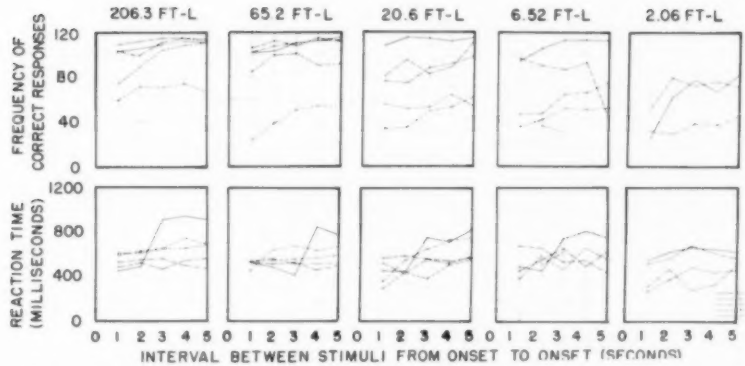

Fig. 3. Data for subject 1. The curves in each graph represent different levels of contrast. The duration of exposure was constant at 50 msec.

fore be ignored since they are so small a percentage of the total. At the lower levels of luminance and contrast, the experiment was discontinued when the subject reported that the target could not be seen at all.

Figure 4 gives the data for two subjects for varying duration of exposure from 0.030 to 0.150 seconds at various levels of contrast representing a total of 2,900 presentations each. These data are plotted in the form of raw scores and average reaction times as functions of duration at different contrast levels.

Figure 5 shows the effect of fatigue, adaptation, etc., upon the reaction time and raw scores, incurred during a long (two-hour) series of runs using the same stimulus conditions. The rate was constant at one presentation every three seconds. Not more than four minutes elapsed between any pair of runs.

DISCUSSION AND CONCLUSIONS

At the outset it must be emphasized that this is a preliminary study. It was not known what effect would be produced by such factors as fatigue, adaptation or learning. Consequently, no attempt was made in planning the experiment to control, minimize or randomize these factors. In general, the plan followed in the major experiment was to select a given contrast, and for various levels of luminance, perform runs at different rates going from the slowest to the fastest. One such series of runs was made during each session. At least one hour of rest intervened between such series of runs.

In the experiment involving variation in duration, the runs performed during a given session were for different levels of contrast for a given duration, rate and level of luminance.

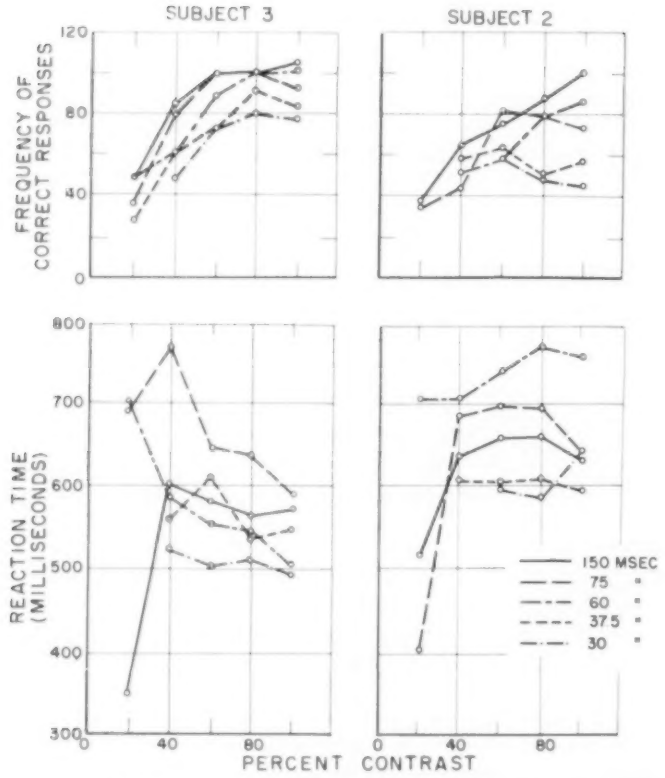

Fig. 4. Data for subjects 2 and 3. The different curves for each graph represent different durations of exposure. The rate was constant at one exposure every three seconds and the luminance was constant at 20.6 footlamberts.

One series of runs was deliberately carried out to test the effect of fatigue, learning, etc. The results are presented in Figure 5 and show that there are changes in reaction time and frequency of seeing. Although there appear to be no unusual skills involved in pressing the keys, the subjects reported greater facility in pressing the key as a result of practice. At the fastest rate, skill in pressing the right key does become a factor. The subject may actually become confused and frustrated, and fail to press any key under these circumstances.

No systematic effort has yet been made to repeat the data under the same conditions to determine reliability. The evaluation of the reliability has to be based upon the smoothness of the curves representing

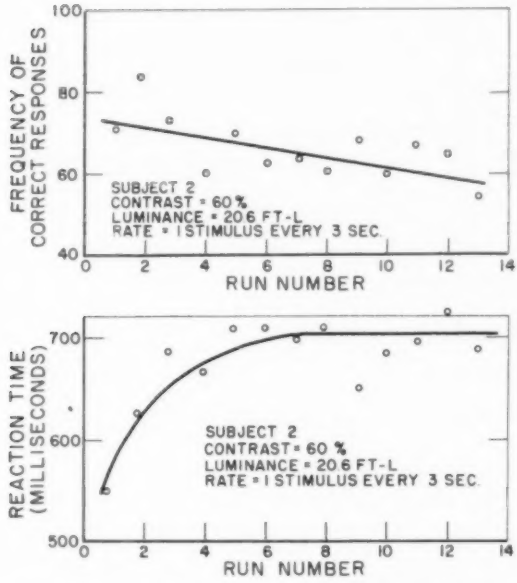

Fig. 5. Frequency of correct responses and reaction time as functions of the number of runs under constant conditions of contrast (60%), luminance (20.6 footlamberts), presentation rate (once every three seconds) and duration of exposure (50 msec.).

the data. It would also be helpful in ironing out some of the irregularities in the data, to repeat several times the experiments described in this report, and to use averages based upon all of the data.

It was possible to complete data for only one subject. Additional subjects must be used before individual differences can be evaluated and before the results can be used for most practical applications.

The apparatus was a pilot model and the study has clearly brought out its major limitation, namely, that its rate of presentation is too limited at the upper level.

Graphical analysis of the data makes certain trends apparent. There appears (Figure 3) to be no significant difference in the results for the three slowest rates at each of the luminance levels. The data for these points were averaged and plotted (Figure 6).

In general, it is possible to treat data such as presented in Figure 6 by correcting them for guessing and fitting each set with the integral of the probability curve as shown in Figure 7. However, due to irregularities and incompleteness, particularly at lower contrasts, the data hardly warrant such a treatment. A logarithmic scale is used for con-

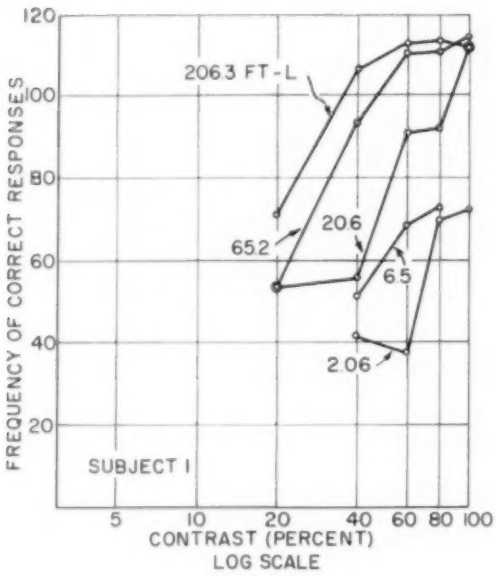

Fig. 6. Relationship between frequency of correct responses and log contrast for various levels of luminance. The data for the 3 longest curves in Fig. 3 have been averaged.

trast in Figures 6 and 7, but whether this is more satisfactory than a linear scale has yet to be determined.

From the curves in Figure 7 it will be possible to draw a graph of contrast as a function of luminance, for various frequencies of seeing. See Figure 8. Such a graph can be used in illuminating engineering for predicting the effects of increasing luminance upon performance.

Although it is not apparent from Figure 6, and more data are neeeded to prove the point, it may be assumed from what is already known about visual acuity, that there is an upper limit of luminance beyond which the frequency of seeing curve will not shift to the left in Figure 6. This means, that at the lowest levels of contrast, it is not possible to achieve 100 per cent seeing by increasing the level of luminance.

Weston (p. 145)[2] handles this phase of the problem by defining performance at the level of 453 footlamberts as the 100 per cent level of performance. This, of course, is a measure of relative performance but it provides a convenient way of predicting improvements from increasing luminance. However, Weston's concept of relative perform-

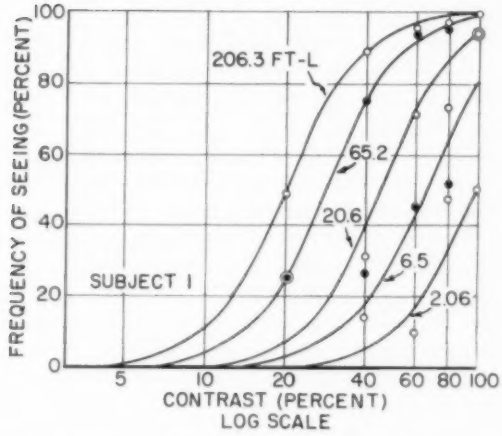

Fig. 7. Frequency of seeing as a function of log contrast. The data in Fig. 6 have been converted to terms of frequency of seeing and the data for each luminance level have been fitted for the curve representing the integral of the probability curve.

ance becomes useless in comparing performance at one level of contrast with that at another. Performance in terms of frequency of seeing gives an absolute measure of performance in terms of which the effects of the various variables, such as duration, contrast or blur can be assessed.

In determining the reaction time for the detection of the presence of an easy to see stimulus, the luminance was 206.3 footlamberts, contrast was 100 per cent and the size of the gap in the ring was 4.5′. The motor was turned on and off for each stimulus to avoid rhythm and other extraneous cues to the onset of the stimulus. The duration varied from presentation to presentation. The average reaction times for

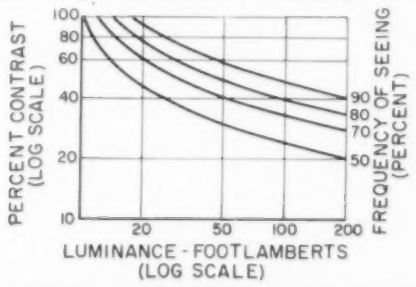

Fig. 8. Combinations of contrast and background brightness which produce various levels of seeing.

three subjects, for 50 presentations each, are as follows:

Subject	Reaction time (seconds)
1	0.2584
2	0.1996
3	0.2200

Since a typical reaction time for a response to an oriented broken ring is of the order of 0.600 seconds, it is obvious that the larger portion of this time is devoted to discrimination.

The relationship of the rate of presentation to reaction time and performance (raw score) is interesting. One obtains a high degree of accuracy at the slower rates but the reaction time is higher than for the faster rates. This is particularly evident in the first three graphs in the lower row of Figure 3 for the higher levels of contrast. It would appear in these instances, that the subject simply takes his time in deciding what response to make.

Another interesting finding occurs with the low levels of luminance and contrast. At these levels at which the performance is hardly more than pure guessing, the reaction time drops to a level approaching reaction time for detection. The subject is apparently anticipating that he will not be able to perceive the orientation of the break in the ring and is prepared for a guess at the onset of the stimulus.

In the more typical situation, in which the subject gives evidence of seeing, and hence, making an effort to see in each case, the typical reaction times range between 0.500 and 0.700 seconds. Increasing the rate both speeds up the reaction but also diminishes the frequency of seeing. Obviously there is some point where control of rate will yield optimum performance when the assessment of performance is based upon both speed and accuracy.

It is interesting to note that the extra long reaction times taken by the subject when the rate of exposure was slow and the target was easy to see did not correspondingly improve performance.

In this particular kind of visual task, where the maximum reaction time required by the subject is of the order of 0.600 second, the subject still has 0.400 seconds to get prepared for the next stimulus when the rate is once per second. If one can therefore tolerate a slight loss in frequency of seeing, there is no reason why the subject should not be paced at a rate as high as one per second in this type of visual task. Whether visual fatigue would take a toll over a long period of time at this rate has not been specifically investigated, although the subjects complained at the highest rate about the fear of getting mixed up. At the slowest rates the subject complained about being bored with wait-

ing for the next stimulus. For the three subjects used in this experiment the rate of one presentation every three seconds was preferred. This rate appears to yield a level of performance at least equal to that of the slower rates. It is recommended, therefore, that this rate be used in studies where it is essential to obtain maximum frequency of seeing scores unimpaired by time factors.

It would be interesting to arrange the apparatus so that the new stimulus is presented at the same time that the subject makes his response. In this way, the subject could set his own pace.

The apparatus could also be arranged so that each stimulus is presented prior to the response to the preceding stimulus. Some such arrangement would be necessary to analyze the factors involved in a visual task like reading.

The data indicate, in general, an increase in performance with an increase in duration but the durations employed did not include those long enough to determine the critical duration beyond which further increase would not improve performance. The data, therefore, apply only to visual tasks involving momentary exposure. Eye movements, such as occur in reading, result in fixational pauses of the order of 0.200 second or longer.

The present study did include an investigation of the effect of duration of exposure on reaction time. The results are shown in Figure 4. At the lowest levels of contrast where performance approximates guessing, there is evidence that the subjects in some of the runs anticipated that they would not be able to perceive the orientation and were ready with a guess at the onset of the stimulus. The reaction time approximates the average action time for this situation. Under circumstances where the subject is obviously making an effort to see, the reaction time increases with the duration of the stimulus for the three lowest levels, but at the highest levels, the reaction time decreases, indicating that the subject does not wait until the end of the stimulus before putting into operation his discriminatory processes.

SUMMARY

A preliminary study of visual performance using a Landolt ring was performed over a range of luminance and contrast with variations in the time factors of rate and duration of exposure to discover their effects, if any, upon performance and upon each other. The data were graphically analyzed to determine the interaction of the various factors involved in the task.

The use of intermittent presentation of the stimulus permitted the accuracy aspect of visual performance to be evaluated in terms of frequency of seeing.

The effect of presentation rate on frequency of seeing at various levels of contrast was studied. An optimum rate of one target every three seconds was indicated by the data.

Reaction time varied with the rate of presentation and there are indications that there is a point where control of rate will yield optimum performance when considered in terms of speed and accuracy. Reaction time varied with the duration for the three lowest levels (of duration), but at the highest levels, the reaction time decreases.

Curves representing frequency of seeing as functions of luminance and contrast were derived. Curves of this type can be applied to illuminating engineering problems, but more subjects would have to be used to obtain curves useful for this purpose.

Furthermore these curves are based on a fixed rate of presentation and duration of exposure and do not take into account the variations in speed which might occur if the subject were allowed to set his own pace.

Also the data in this study apply to the special case in which the subject looks directly at the center of the Landolt ring and no search or use of peripheral vision is required except in so far as the subject fails to look where he is supposed to look. With durations of the order of 150 msec. and less a subject is not likely to benefit from changing fixation in the middle of an exposure.

For this very special task the data do indicate the effect of varying rate and duration of exposure on frequency of seeing at various levels of contrast and luminance.

The study has also proved useful in showing how varying the duration, luminance and contrast affect the time required for discrimination, and how the subject reacts to an increased rate and to an awareness that he is merely guessing. These relationships are quite important when trying to understand why speed of performance varies when the subject is allowed to regulate his own speed.

A minor experiment has been included in this study to determine the effect of fatigue on reaction time and frequency of seeing. Measureable impairments were found.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to his subjects for their cooperation and assistance, to Miss Mildred Hindman for preparing the drawings, to the U. S. Air Force Rome Air Development Center for the use of the equipment, to the Bureau of Medicine and Surgery, U. S. Navy, for the opportunity to participate in graduate study in Physiological Optics at The Ohio State University School of Optometry, and to Dr. Glenn A. Fry and Dr. Jay M. Enoch for their encouragement and direction which made the project possible.

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ANNOUNCEMENT

CONTACT LENS POST-GRADUATE COURSE AT PENN STATE

The Pennsylvania State College of Optometry announces that the next post-graduate contact lens course will begin on April 11, and will continue until April 17. As presented at the College, the Contact Lens course stresses both the theoretic and the practical aspects of Contact Lens Practice. It includes 21 hours of class room lecture, and 28 hours of laboratory work. The lecture time is divided to cover the following aspects of Contact Lens Practice: (1) Ocular Pathology and Contact Lenses (Dr. Harold Simmerman), (2) Ocular Anatomy and Contact Lenses (Mr. Onofrey Rybachok), (3) Contact Lens Optics (Dr. Frederick Sinn), (4) Evolution of the Contact Lens (Dr. J. C. Neill). Where necessary, mimeographed material will be distributed in conjunction with the lectures.

The clinical session is held between one and five o'clock each day, and is under the supervision of Dr. John C. Neill. During this time, each post-graduate student will practice on an assigned patient. His procedures with the patient begins with keratometric determinations and is followed by trial case fitting of the case, based on the above calculations. Each student will learn to subject the fit of the lenses to lag analysis, fluorescein patterning, and slit lamp cleearance studies. Corneal abrasions are considered in conjunction with fluorescein patterning.

During clinical time, Dr. William Policoff will instruct the students in lens manipulations, including reduction of diameter, and lens polishing. Each student will be familiarized with the operation of all instruments now available for determining the various contact lens dimensions.

The course is limited to twelve optometrists. The fee is $100.00 for attendance per student. For registration write to the Pennsylvania State College of Optometry, 12th & Spencer, Philadelphia.

RECOGNITION OF COLOR CODE BY NORMALS AND COLOR DEFECTIVES AT SEVERAL ILLUMINATION LEVELS. AN EVALUATION STUDY OF THE H.R.R. PLATES*

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INTRODUCTION

The relationship has been established between the ability of normals and color defectives to recognize the color code of resistors and their quantitative classification according to the H.R.R. plates and the Ishihara test.

For selection among color defectives the H.R.R. plates are better than the Ishihara. At normal illumination mild classifieds read color code as well as normals do.

For low illuminations the performance of mild color defectives turned out to be approximately equivalent to the results obtained by normals at a level of illumination reduced six times.

This relationship between mild color defectives and normals qua color recognition could also be revealed in experiments on color discrimination with the use of the H.R.R. plates as a function of the illumination.

I. INTRODUCTION

Sloan and Altman[1] have stated the following: "In future evaluations of tests for degrees of color deficiency, it is highly desirable that such tests be compared not only with one another, but also with performances representative of the color-discriminations required by various occupations."

In our study we compared the performance of color code recognition with the classification in degree of color deficiency by means of several pseudo isochromatic tests. In an analogous study Hardy[2] found that people classified as "mild" with the H.R.R. plates could read color code as well as normals do at a normal illumination. As can be seen in the following paragraphs, we can confirm their conclusion.

We extended our study for low illumination levels, because in practice color code identifications often have to be done when e.g. only pocket torches are available. We will describe our findings with a series of illuminations in relation to the classification with the H.R.R.

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Fig. 1. A subject sitting before the color code test. He is almost ready to write down the names of the colors of the code bands. When he is ready, he pushes the button on the left side of the desk under his thumb, and a new resistor appears, together with a blank piece of paper.

plates in the hope that we may contribute something of value in accordance with Sloan and Altman's desideratum.

Finally we tried to compare our results with the color discrimination ability of normal and color defective people as a function of the illumination.

2. PROCEDURE

Sixty-nine different resistors, each with three colored code bands were presented one by one to the subject (Figure 1). The subject was given a list of the possible names. He had to write down only the names of the colors and could look as long as he wished. Just before the procedure began, the subject was shown a pattern card of the color code used and their names. The mean time for a whole series of resistors was 15 minutes.

The colors of the body and the bands, lighted with illuminant A, are shown in Figure 2. The background, on which the resistors were mounted, was gray. All resistors available in practice were used in the test, the number of presentations of the various colors being the

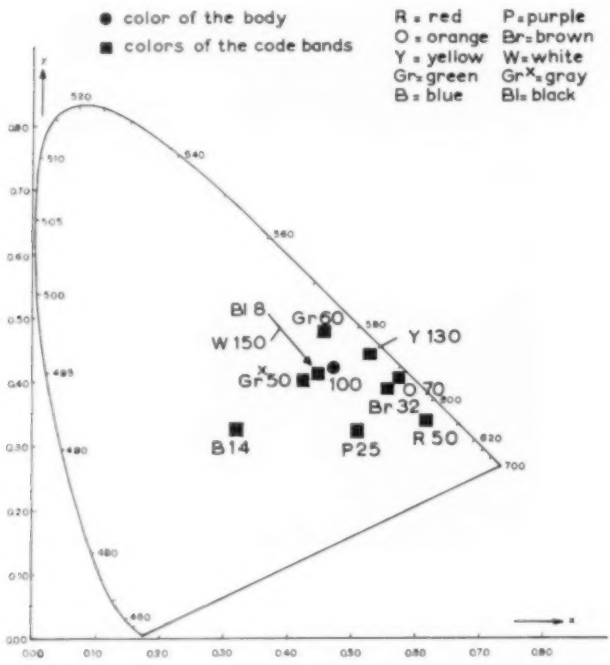

Fig. 2. The color coordinates of the code bands and the body (with illuminant A) plotted in the CIE color diagram. The numbers indicate the remission in percentages in proportion to the remission of the body.

following: black 19, brown 36, red 41, orange 30, yellow 18, green 19, blue 10, purple 11, gray 17, white 6. The total number was 207. For the interpretation we used the total number of mistakes and the kind of mistakes.

The results are compared with the quantitative classification ("mild," "medium" and "strong") according to the Hardy, Rand and Rittler (H.R.R.) plates (1st edition, 1955) and the score (number of misreadings) on the Ishihara (10th edition, 1951), both illuminated with illuminant C, 500 lux.

3. Results

a). High illumination level.

The first part of our study deals with the number of mistakes as a function of Ishihara score and H.R.R. classification for 57 color defective (mild 19, medium 12, strong 26) and 24 normal subjects, at 500 lux.

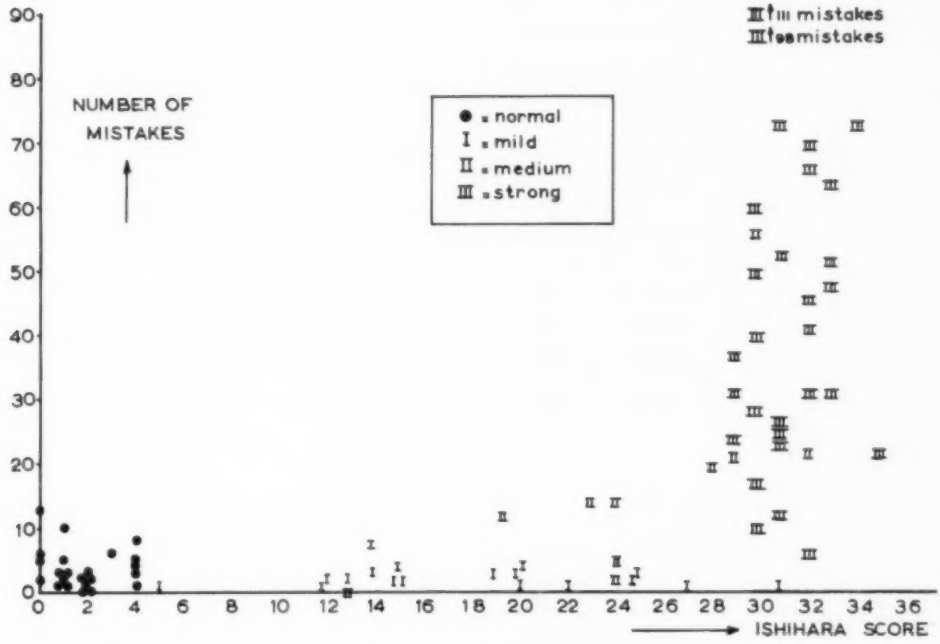

Fig. 3. The number of mistakes in the color code test at a illumination of 500 lux, as a function of the Ishihara score. Roman numbers indicate H.R.R. classification.

From Figure 3 it can be seen that up to Ishihara score 16 the number of mistakes by color defectives is as small as in normals. If we look at the H.R.R. classification, it turns out that in I (mild) only a few, and in II (medium) and III (strong) many mistakes are made. From all the color defectives having less than 10 mistakes (that is as good as normals) 75 per cent are classified as mild, and only 45 per cent have a lower score than 16. Since there is also no difference in the kind of mistakes made by normals (the interested reader is invited to ask for the Institute report),[4] the H.R.R. plates must be regarded as more efficient for the selection among color defectives. The H.R.R. plates thus being better than the Ishihara for our purpose, we went on to study the influence of the illumination level only in correlation with the H.R.R. classification.

b). Variation of the illumination.

This study was done with a more limited number of subjects: 8

normal, 13 mild deutans, 1 mild deutans, 1 mild protan, 4 medium deutans, 3 medium protans, 4 strong deutans and 7 strong protans.

In Figure 4 the mean number of mistakes for each group is plotted against the illumination level. In Figure 5 the spread of the curves for the normals and mild deutans can be seen. For the other groups the spread is almost the same being somewhat larger for the strong defects. The results of Figure 5 as to the DI-group can be described by a shift of the error curve of the normal subjects to an illumination six times lower. This opens the possibility for normal subjects to imagine themselves in the position of the mild deutan, supposing that not only the number, but also the kind of mistakes are equal. Indeed, they are almost the same. In Table I a comparison is shown, from which at first sight the maxima lie almost on the same places. (For results on other illuminations, see Figure 4).

TABLE I

Naming of the Colors

Colors Presented	Bl	Br	R	O	Y	Gr	B	P	Gr[x]	W	Bl	Br	R	O	Y	Gr	B	P	Gr[x]	W
Bl		8	1	1		4	10	7				1	1		1	1	39	2		
Br	15		17	1		2	3	22	2		9		13	0		5	14	27	1	
R	2	11		18		2		5	1		0	4				3		5	1	
O		1	13		2			1	1	1			8		3	1		0	1	
Y				3					2	10				3		1	1		5	17
Gr	1	5	1	4			14	1	20		1	8	12	1			21	5	18	
B	21	4	1			2		10	3		31					2		10		
P	30	11	3			4	6		3		20	5	4	1		5	20		3	
Gr[x]	1	6	1	2		35	8	3				2	18	1		28	18	4		
W				4	26			2					2		15				2	
	DI, 4 lux										N, 0.6 lux									

Table I. Comparison between the color naming results of the deutan mild group at 4 lux and the normal group at 0.6 lux. Each number represents the percentage of the color presented, which received a certain name. For easy comparison the numbers above 10 are underlined.

Accurate comparison shows, however, a few more typical tritanopic confusions, like blue-black and gray-blue confusions for the deutan-milds. It is, therefore, useful to split up the mistakes in red-green and yellow-blue confusions.

In Figure 6 these confusions are plotted separately as a function of the illumination. These figures show that for the yellow-blue mistakes a shift of 10 x has to be made, and for the red-green mistakes

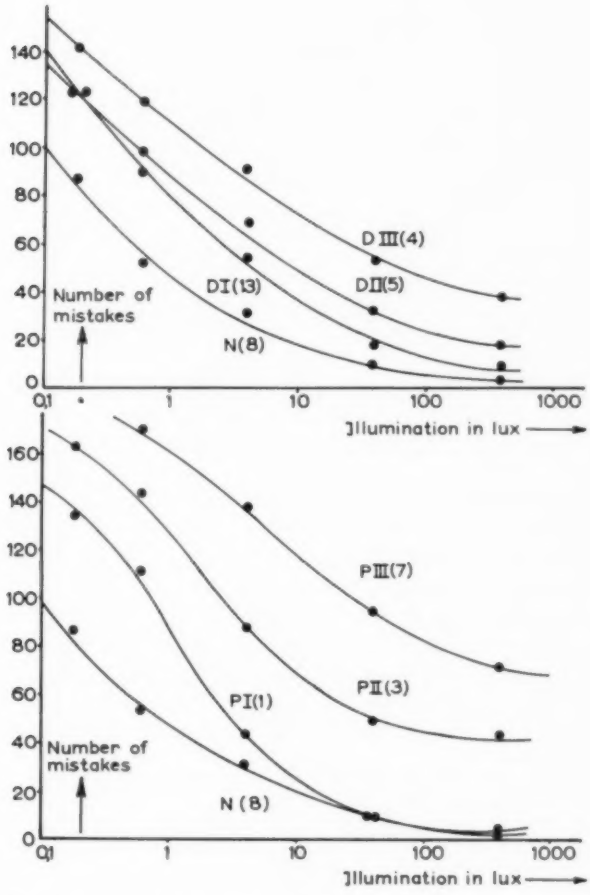

Fig. 4. The number of mistakes as a function of the illumination: for normals (N), deutans (D), and protans (P). The Roman numbers indicate H.R.R. classification, the numbers between brackets, the number of subjects used.

only 4 x for coincidence. The frequency of yellow-blue mistakes being lower than of red-green confusions the resulting mean value is the 6 times mentioned.

For the medium and strong classified groups it is more or less possible to calculate an analogous illumination shift, but here the kind of the mistakes diverges widely.

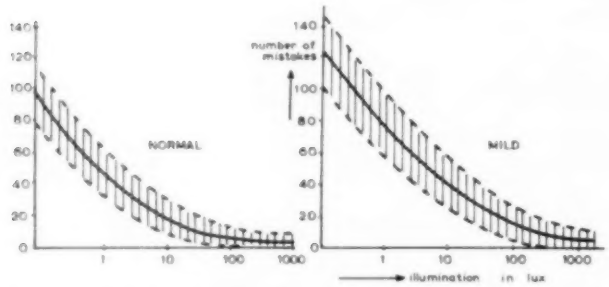

Fig. 5. The spread in results among normals and milds. The dotted lines indicate the extreme values occurring. A shift of about five times in illumination makes the normal and the mild curves coincide.

Combining the results of the PI at the several illuminations and the two PI's at 500 lux, it is probable that the behavior of DI's and PI's is approximately the same. So we can treat the DI's and PI's as one group: mild.

Our conclusion must be, therefore, that the mean mild makes as many mistakes as the mean normal at an intensity six times lower, the mistakes being of approximately the same kind, leaving aside a small difference between yellow-blue and red-green confusions.

4. COMPARISON WITH COLOR DISCRIMINATION DATA

Can this rule of the illumination shift of six times be made understandable by using the behavior of color discrimination as a function of brightness? To determine this behavior we used the H.R.R. plates. In Figure 7 the coordinates of the colors are plotted in the color dia-

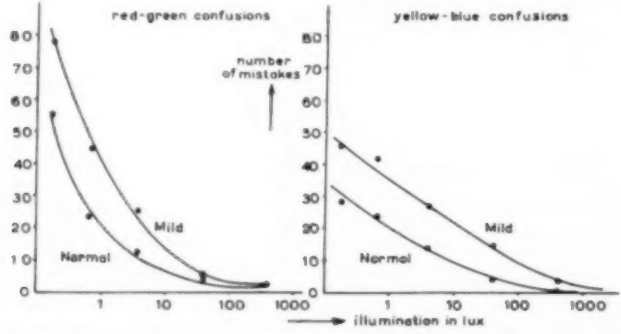

Fig. 6. The numbers of mistakes, split up in red-green and yellow-blue confusions. For r-g-confusions a shift of 4 times, and for y-b-confusions a shift of about 10 times is necessary for coincidence of normal and mild curves.

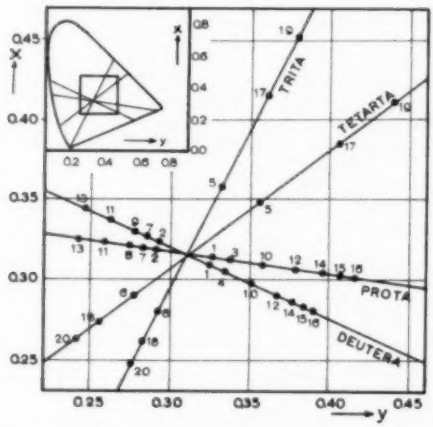

Fig. 7. The color coordinates of the H.R.R. plates plotted in the CIE color diagram. The numbers indicate the pages on which these colors are printed.

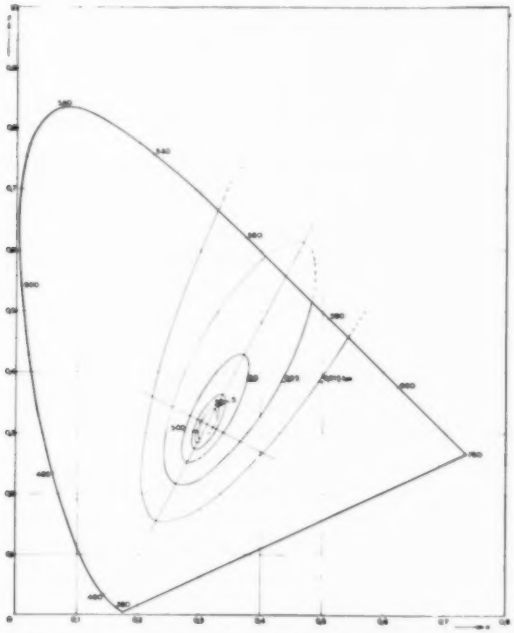

Fig. 8. Discrimination ellipses for reading H.R.R. plates at several illuminations for the mean normal. The centers of the ellipses do not coincide in the CIE diagram. This would only be the case in an equal brightness color diagram.

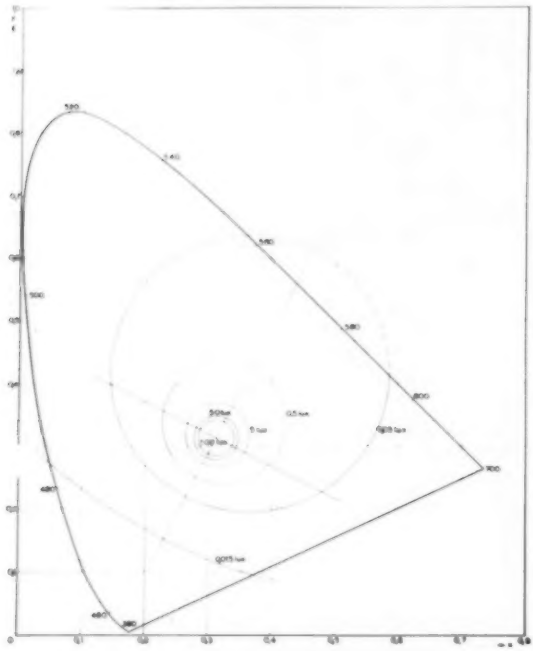

Fig. 9. Discrimination ellipses for reading H.R.R. plates at several illuminations for the mean mild.

gram. They were determined by comparing with the Munsell book and converted into CIE-coord. with the Nickerson tables. Colors, which gave troubles by the Purkinje shift, like the blue tetartanopic colors, are not used.

Discrimination ellipses for reading H.R.R. plates are determined for six normal and four mild subjects. To correlate the results with the behavior of the milds in the foregoing paragraphs, we have to use the color discrimination of the mean mild. It happened that our color defective subjects had a slightly better color discrimination than the mean mild, but the data were extensive enough to calculate the behavior of the mean mild. The results are given in Figures 8 and 9. A part of the curves are extrapolated, which was easily possible. From the figures it can be seen that the yellow-blue discrimination of the milds is not significantly different from the normals. This was even the case for a strong protanope and a strong deuteranope.

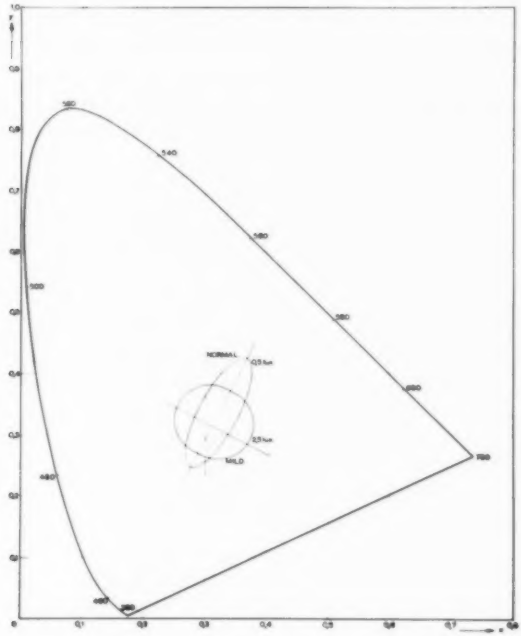

Fig. 10. Two ellipses of equal area, the normal one being at a five times lower illumination.

In our opinion the most obvious chance of finding a correlation between color naming and color discrimination is to assume that the

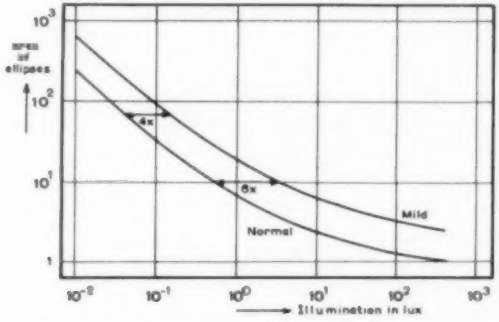

Fig. 11. The areas of the discrimination ellipse as function of the illumination, for the mean mild and the mean normal. The area of the normal at 500 lux is used as unit-area.

ability to name colors correctly is proportional to the number of ellipses that can be placed in a certain area of the color diagram or in other words is inversely proportional to the area of the ellipse. The areas of the ellipses of the normals and milds are compared in Figure 11. We see that a shift of four to six times gives almost a coincidence of the curves. In Figure 10 two ellipses of equal area are shown, the illumination ratio being five times. In principle discrimination ellipses of anomalous people should not be drawn in a normal mixture diagram, because metameric colors for the normal may be not metameric for anomalous. Here, however, this is not the case, and if one remembers not to use these ellipses for other spectral distributions, and in practice these distributions do not differ much, no difficulties are encountered.

Hence the illumination shift we found in the study on color recognition is found back for getting equal area of the discrimination ellipses. Our suggestion that the capacity to name colors correctly is inversely proportional to the area of the ellipse seems, therefore, to be justified in spite of the fact that the mild has even more yellow-blue confusions with respect to red-green confusions. One would not expect this from the form of the ellipses.

The possibility, however, mentioned earlier, for normal subjects to imagine themselves in the position of the mild color deficient observer by decreasing the illumination six times is supported by this research on color discrimination.

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COMBINED EFFECT OF VITAMINS A AND E ON DARK ADAPTATION IN MAN*

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It is generally accepted that the test of dark adaptation is not only a necessary prerequisite for night fliers, but important also in determining avitaminosis. McFarland, Graybiel and their associates[3] tested the dark adaptation of air line aviators in an attempt to appraise symptoms of vitamin A deficiency. The results showed that 4.5 per cent of the aviators had poor dark adaptability. In a similar study Flynn[1] found that 6.4 per cent of the aviators had a deficiency in dark adaptation. As a result of supplementing their diets with vitamin A, their ability to dark adaptation showed a significant improvement. The purpose of the present work is to investigate the possible effectiveness of large doses of vitamin A and/or vitamin E on rod dark adaptability for subjects who do not suffer from vitamin A deficiency.

METHODS

Observations on the absolute threshold for light intensity during the process of dark adaptation were made by means of Nagel's adaptometer. The test field occupied a visual angle of 3° diameter, situated 15° above the subject's fovea. Both eyes of the subject were first exposed to a light of 200 millilamberts for light preadaptation for 15 minutes. During the subsequent time in darkness, the subject was instructed to adapt the adjusting wheel of the adaptometer with his right hand until he just no longer perceived the dim white light of the test field. The light intensity of the presentations were determined before the measurements. The adjustments of each subject was repeatedly done at desired time intervals and the disappearance thresholds thus obtained were given as the lagarithm of the brightness in micromicrolamberts ($\mu\mu$). The source of light for the adaptometer and the light preadaptation apparatus was supplied by a steady and constant 100 volts battery.

RESULTS

Two subjects (F and H, weighing 69 and 50 Kg., respectively)

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TABLE 1 THE EFFECTS OF VITAMIN A AND/OR VITAMIN E ON ROD DARK ADAPTATION FOR SUBJECT F

Time in Dark (Average and Min. Range)	Control	LOG INTENSITY (MICROMICROLAMBERTS)				
		VITAMIN A	VITAMIN E	Vitamin A(150000) I. U. and E(200 Mg)	Vitamin A (200000 I.U.) and E (400 Mg)	Vitamin A (200000 I. U.) and E (500 Mg)
		200,000 I. U.	300,000 I. U.	300 Mg.	500 Mg.	
		TIME AFTER VITAMIN A AND/OR E INTAKE (HR.)				
		1.0	4.0	1.0	7.0	27.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	4.0	8.3	26.5	1.0	25.0	49.0	73.0	99.0	122.0
1	5.73 (5.67-5.76)	5.75	5.74	5.74	5.74	5.78	5.75	5.75	5.79	5.74	5.69	5.73	5.74	5.76	5.76	5.76	5.75	5.62	5.74	5.70	5.77	5.77
3	5.36 (5.31-5.36)	5.35	5.33	5.32	5.36	5.32	5.32	5.36	5.34	5.36	5.25	5.31	5.35	5.37	5.33	5.36	5.33	5.36	5.28	5.16	5.33	5.39
5	4.96 (4.93-4.98	4.87	4.96	4.99	4.93	4.86	4.89	4.98	4.86	4.89	4.87	4.99	4.86	4.96	5.00	4.99	4.72	4.59	4.42	4.61	4.99	4.97
8	4.28 (4.25-4.33)	4.29	4.23	4.26	4.25	4.29	4.17	4.31	4.19	4.31	4.23	4.29	4.31	4.34	4.27	4.31	4.19	4.09	4.12	4.14	4.27	4.24
10	3.94 (3.88-4.01)	3.91	4.03	3.90	3.89	3.91	3.86	3.89	3.81	3.99	3.72	3.94	3.98	4.02	3.74	3.99	3.86	3.85	3.84	3.81	3.74	3.94
15	3.10 (3.06-3.13)	3.05	3.10	3.09	3.12	3.10	3.08	3.15	3.03	3.09	3.07	3.13	2.98	3.10	3.07	3.09	2.95	3.04	3.03	3.06	3.00	3.12
20	3.03 (3.01-3.04)	3.04	3.07	3.01	3.04	3.05	2.93	3.01	2.98	3.01	2.96	3.09	2.93	2.95	2.97	2.99	2.84	2.89	2.83	2.95	2.98	3.03
25	2.90 (2.88-2.93)	2.93	2.89	2.91	2.89	2.93	2.89	2.89	2.90	2.90	2.84	2.91	2.84	2.84	2.84	2.93	2.81	2.82	2.79	2.76	2.84	2.81
30	2.79 (2.76-2.81)	2.80	2.84	2.81	2.81	2.78	2.73	2.78	2.78	2.81	2.81	2.79	2.75	2.72	2.76	2.80	2.72	2.66	2.72	2.67	2.72	2.67
35	2.74 (2.69-2.76)	2.76	2.70	2.72	2.72	2.70	2.67	2.72	2.76	2.74	2.69	2.72	2.67	2.66	2.66	2.72	2.54	2.54	2.59	2.57	2.59	2.67
40	2.69 (2.67-2.73	2.69	2.67	2.67	2.67	2.69	2.66	2.60	2.67	2.69	2.67	2.67	2.57	2.59	2.60	2.67	2.50	2.48	2.53	2.51	2.57	2.62

TABLE 2. THE EFFECTS OF VITAMIN A AND/OR VITAMIN E ON ROD DARK ADAPTATION FOR SUBJECT H

Time in Dark Min.	Control (Average and Range)	LOG INTENSITY (MICROMICROLAMBERTS)																					
		VITALIN A				VITAMIN E				Vitamin A (150000 I.U.) and E (200 Mg.)		Vitamin A (200000 I.U.) and E (400 Mg.)				Vitamin A (2000000 I.U.) and E (500 Mg.)							
		100000 I. U.		200000 I. U.		300 Mg		500 Mg															
		TIME AFTER VITAMIN A AND/OR E INTAKE (HR.)																					
		1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	3.0	6.0	1.0	4.0	9.0	25.0	1.0	4.0	25.0	49.0	57.0	74.0	
1	5.67 (5.63-5.71)	5.61	5.61	5.60	5.59	5.60	5.57	5.56	5.58	5.59	5.55	5.61	5.35	5.32	5.12	5.51	5.26	5.12	5.09	5.38	5.38	5.53	
3	5.41 (5.36-5.48)	5.31	5.29	5.35	5.35	5.33	5.29	5.25	5.29	5.29	5.26	5.29	4.66	4.87	4.42	5.16	4.91	4.56	4.59	4.89	4.89	4.99	
5	4.94 (4.86-5.02)	4.83	4.81	4.83	4.83	4.76	4.77	4.72	4.83	4.86	4.66	4.81	4.29	4.25	4.21	4.42	4.21	4.12	4.09	4.29	4.29	4.51	
8	4.41 (4.38-4.44)	4.35	4.37	4.36	4.37	4.33	4.33	4.21	4.31	4.36	4.36	4.34	3.99	4.07	3.81	4.23	3.93	3.99	3.94	3.96	3.99	4.12	
10	4.00 (3.96-4.06)	3.88	3.89	3.91	3.91	3.91	3.88	3.82	3.85	3.89	3.88	3.92	3.12	3.51	3.17	3.72	3.61	3.36	3.36	3.51	3.42	3.59	
15	2.97 (2.93-3.01)	2.88	2.88	2.91	2.90	2.89	2.91	2.90	2.92	2.86	2.89	2.88	2.76	2.81	2.79	2.88	2.79	2.67	2.76	2.81	2.81	2.83	
20	2.72 (2.69-2.78)	2.66	2.69	2.64	2.63	2.70	2.68	2.57	2.66	2.58	2.67	2.69	2.66	2.53	2.56	2.67	2.51	2.53	2.57	2.67	2.53	2.63	
25	2.54 (2.50-2.56)	2.49	2.49	2.48	2.50	2.50	2.50	2.46	2.48	2.47	2.48	2.47	2.36	2.36	2.43	2.45	2.33	2.26	2.34	2.40	2.42	2.43	
30	2.47 (2.42-2.48)	2.38	2.38	2.39	2.42	2.42	2.39	2.40	2.40	2.40	2.36	2.42	2.27	2.29	2.33	2.39	2.17	2.14	2.23	2.34	2.37	2.34	
35	2.38 (2.36-2.42)	2.34	2.34	2.36	2.33	2.33	2.33	2.33	2.36	2.25	2.23	2.31	2.24	2.19	2.19	2.33	2.10	2.12	2.19	2.25	2.33	2.32	
40	2.35 (2.31-2.37)	2.31	2.31	2.34	2.31	2.29	2.31	2.30	2.31	2.20	2.25	2.32	2.14	2.19	2.20	2.32	2.05	1.99	2.16	2.25	2.27	2.29	

were selected for test. They were both clinically healthy and well trained in the use of the adaptometer. The control readings were taken until each subject reached a constant level excepting for the slight unavoidable normal variability found in repeated readings. The average and range of the 5 control experiments of each subject and the measurements of the dark adaptability after vitamin A (from Fish Liver Oils, Eli Lilly Company) and/or vitamin E (Distilled Tocopherols, Natural Type, Eli Lilly Company) intake are given in Tables 1 and 2.

After a single dose of vitamin A per os, such as 100,000, 200,000 or 300,000 I.U., no effect was observed. When 300 or 500 mg. of vitamin E was given, the results were similar. If vitamin A was given in addition to vitamin E, the subjects always showed some improvement in dark adaptation. The minimal effective combined dose was different for the two observers: for instance, with an intake of vitamins A (150,000 I.U.) and E (200 mg.) subject F showed no improvement in dark adaptation, while subject H showed a slight improvement. The improvement in dark adaptation was further augmented by combining 200,000 I.U. of vitamin A and 400 or 500 mg. of vitamin E. For simplification, some readings that appeared similar were purposely omitted from the tables. The improved effect commenced about one hour after ingestion of the vitamins. The duration of the combined action varied in different doses, the larger the combined dose, the longer was the improved effect as indicated in Figure 1.

DISCUSSION

It is known that vitamin A is of great importance for the regeneration of visual purple. Hence, poor dark adaptation or night blindness as a result of vitamin A deficiency can be cured by the therapeutic administration of this vitamin. Dark adaptation which is better than normal would be of considerably greater interest to night flying than is the simple therapy of night blindness. Therefore, some studies have been made. In 1947, Rose and Schmidt,[4] reported that dark adaptation could not be improved beyond the normal however much vitamin A was taken. During World War II, Hosoya[2] had an opportunity to study the effect of vitamin A on dark adaptation, he also detected no definite effect from this vitamin. The results here presented are quite in accord with those of the above mentioned investigators.

So far as is apparent, no work has been reported concerning the combined effect of vitamins E and A on dark adaptation. We found no effect on dark adaptation from either vitamin A or E alone. A decided improved effect was observed after the combined administration

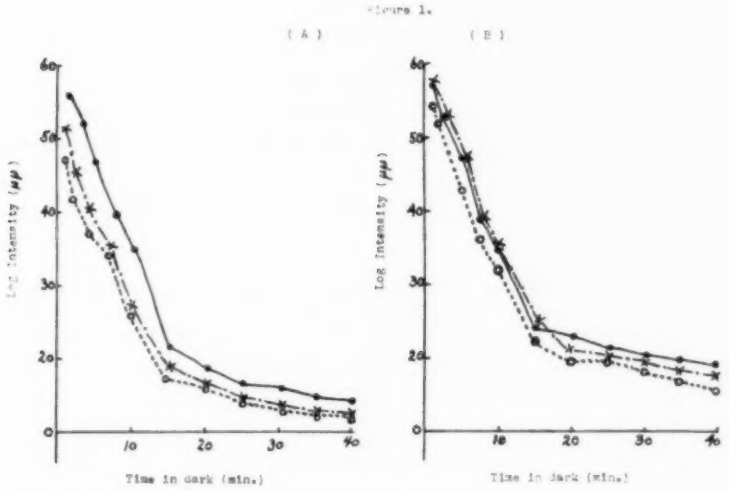

Fig. 1. Combined effect of Vitamin A and Vitamin E on Rod Dark Adaptation. Fig. 1-A. Subject H. Fig. 1-B. Subject F. Solid Circles = control; Crosses = 4 hours after combined dose of vitamin A. (200,000 I.V.) and vitamin E. (400 mg.); open Circles = 25 hours after dose.

of these vitamins. The mechanism of such a peculiar phenomenon is therefore obscure. In 1947 Spaulding and Graham[5] indicated that vitamin E might play a part as a coenzyme protector in the photochemical cycle of visual purple regeneration. Furthermore, it is known that vitamin E itself is an antioxidant; it can protect vitamin A from oxidative destruction. Such physiological actions of vitamin E in association with the action of vitamin A may, therefore, improve the dark adaptability.

SUMMARY

1. A measurement of dark adaptation was made by means of a Nagel's adaptometer for two subjects before and after ingestion of varying doses of vitamin A and E.

2. There was no improvement in rod dark adaptation after either a single dose of vitamin A (100,000, 200,000 or 300,000 I.U.) or of vitamin E (300 or 500 mg.), indicating that greater than normal amounts of vitamin A or E alone do not improve dark adaptation.

3. There was some improvement in rod dark adaptation after oral administration of vitamin A together with vitamin E. The possible mechanism of such a peculiar phenomenon is suggested.

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ANNOUNCEMENT

OMA PUBLIC RELATIONS PROGRAM IN 1960

BETTER VISION INSTITUTE TO CARRY MESSAGE

The Annual Meeting of the Optical Manufacturers Association, held at New York City's Warwick Hotel on January 21, was highlighted by the presentation of a tentative timetable for 1960's Industry Promotion Program.

Following the business meeting, H. P. Brigham, chairman of the OMA Promotion Committee, used full-color slides to show how other groups and industries embarked on similar large scale programs with markedly successful results. He outlined the steps necessary to achieve like results within the framework of the ophthalmic field and gave a timetable leading up to the opening of the campaign sometime in August, to coincide with the 'back-to-school' movement. Mr. Brigham also pointed out that the program would be slanted to a primary market, the housewife and mother, who is in effect the 'custodian' of health services within the family.

1960 Industry Promotion Program, it was revealed, by Mr. Alton K. Marsters, Chairman of the Better Vision Institute Sub-Committee, will be released over the signature of the Better Vision Institute, in response to urging by all facets of the ophthalmic industry. All OMA members participating in the Promotion Program thus become members of the BVI. $750,000 will be spent.

The business meeting was climaxed by election of OMA officers for 1960. Emanuel Nathan of The Opticase Company, Newark, was re-elected president and Eldon R. Siehl of The Vision-Ease Corporation, St. Cloud, Minnesota, was re-elected vice-president. Elected to the Executive Committee were Victor D. Kniss, Roy Marks, Alton K. Marsters and E. Hutson Titmus, Jr.

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ANNUAL REPORT OF THE PRESIDENT*

On behalf of the Executive Council and in my own behalf, I greet you Academy Fellows and guests to this, our thirty-ninth, Annual Meeting. A three day outstanding postgraduate instructional program was completed yesterday under the capable leadership of Dr. Vincent Ellerbrock, Dr. Daniel Hummel and their respective committees. I assure you that the four day program of papers and section meetings which starts immediately after this brief business session will be no less outstanding than the instructional program. Dr. Donald Springer, chairman of the Papers and Program Committee, and Dr. John Zettel, general chairman of the programs of the Sections, have developed the four day program which is about to begin. I know their efforts will

*Dr. Lawrence Fitch, dean, Pennsylvania State College of Optometry, president, American Academy of Optometry. Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 11, 1959.

continue the long established Academy tradition of having the highest calibre scientific meetings. We can look forward to these four days as being most informative and most satisfying to our intellectual curiosity.

I mention the names of these four Academy Fellows in conjunction with our meeting program. I shall mention other names in relation to specific activities. I have a feeling of guilt in not mentioning the names of many other Fellows for the excellent work which they have done for the Academy during the year. The wonderful truth is that so many Fellows have participated so extensively in Academy affairs during the year that it is not practical to include mention of all in this message. The work and responsibility of the President have been made easy by this fine spirit of refusing to "let George do it" and I am most appreciative of the honor and pleasure of working and associating with these Fellows.

This year has been another year of noteable progress for the American Academy of Optometry. It is true that much of this year's progress can be attributed to the progress of former years. We should be ever grateful to the many leaders and workers dedicated to our profession and to our Academy who have made so many contributions to provide us with the status which we enjoy today. A highlight of this Annual Meeting will be our giving of recognition through Honorary Life Membership at our Roundtable Dinner to one of these leaders, Dr. Ralph S. Minor, retired Dean of the College of Optometry of the University of California.

Another highlight of this Annual Meeting which will take place at our dinner meeting will be an address by Dr. P. N. DeVere, President of the American Optometric Association. Dr. DeVere will review the current conditions of the profession in a "State of the Profession" message. One of our profession's problems which Dr. DeVere will most certainly present is that of an impending critical optometric manpower shortage. As your President, on invitation from the American Optometric Association, I participated during the year in two conferences on this subject. I assure you there is a real manpower problem and that it behooves every Academy Fellow to support strenuously the American Optometric Association in any project it undertakes to alleviate this problem.

I hope every one present at this time is aware that the Academy's first home study course is in its final stages at the printers. It is to be available to subscribers in a matters of days. The first course, *A Synopsis of Glaucoma for Optometrists* is authored by Dr. Arthur Shlaifer, an Academy Fellow whose education, writing and teaching experience

assures the high quality of the course. Dr. Meredith Morgan, as Chairman of the Committee on Home Study Courses, has been the overseer of this project. It is hoped that all Academy Fellows will subscribe to this course and make an effort to call its availability to the attention of their optometric acquaintances.

Under the initial guidance of Dr. Henry Hofstetter and the later guidance of Dr. John Perry, respectively, Chairman and acting Chairman of a special committee to establish a program of honor medalist lectures, we are assured that such a program will get under way at future Annual Meetings. The specifications for the medal have been decided upon and deliberations on the selection of the first lecturer to be honored are taking place. Dr. Perry will welcome for his committee's consideration any recommendation of lecturers which any Academy Fellow wishes to offer.

In a few minutes, you will hear our Secretary report that a record number of new Fellows have been welcomed into the Academy this year. The Academy does not engage in open membership drives. However, we want new members. We want optometrists to aspire to Fellowship in the Academy. It is up to us who are Academy Fellows to acquaint our neighbor optometrists with the Academy and to let them know that we are not a country club outfit or other closed organization. Let your neighbor optometrist know that he will be most welcome in the Academy if he desires to join us in supporting the highest scientific and professional standards of optometry attainable for serving the public welfare.

In closing, I wish to pay tribute to "Mr. Academy," our ever faithful, most competent secretary, Dr. Carel C. Koch. The Academy is most fortunate in having a man of Dr. Koch's capabilities and industry in this key position. And, I am most fortunate and appreciative to serve as President with this pillar of strength and help at my side.

LAWRENCE FITCH

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A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

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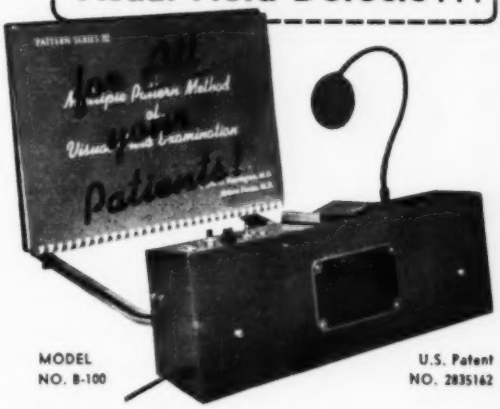

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ILLINOIS COLLEGE
of OPTOMETRY
3241 So. Michigan Ave.
Technology Center, Chicago 16, Ill.

WALCO

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COMPLETE YOUR PROFESSIONAL AND CLINICAL BACKGROUND IN OUR Comprehensive 3-Day Contact Lens School

Mueller Welt has concentrated its vast experience, and its current developments and techniques, in a course which brings you up to the minute, technically and clinically, in fitting contact lenses. You will have three days of intensive practical study, including at least nine hours of clinical work on actual patients. The course covers both beginning and advanced fitting. Emphasis is placed on individual understanding; your three instructors are very well qualified and classes are *limited to twelve students*. TUITION $75.

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ONLY 12 STUDENTS PER CLASS!
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1960 CLASS SCHEDULE

FEBRUARY			MARCH			APRIL		
M	T	W	M	T	W	M	T	W
1	2	3	Feb.		March	4	5	6
15	16	17	29	1	2			
			7	8	9			

MAY			JUNE		
M	T	W	M	T	W
2	3	4	6	7	8
23	24	25	20	21	22

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Never before has such a small creation meant so much in the field of sight—or brought so much new beauty in fuller enjoyment of life to so many.

The above photograph represents the finest attributes of craftsmanship, character, and professional skill as exemplified by you. It bespeaks volumes. A 22 inch by 19 inch mat finish print, suitable for framing, of this unusual photo may be ordered from The Plastic Contact Lens Company.

THE PLASTIC CONTACT LENS COMPANY

5 South Wabash Avenue, Chicago 3, Illinois